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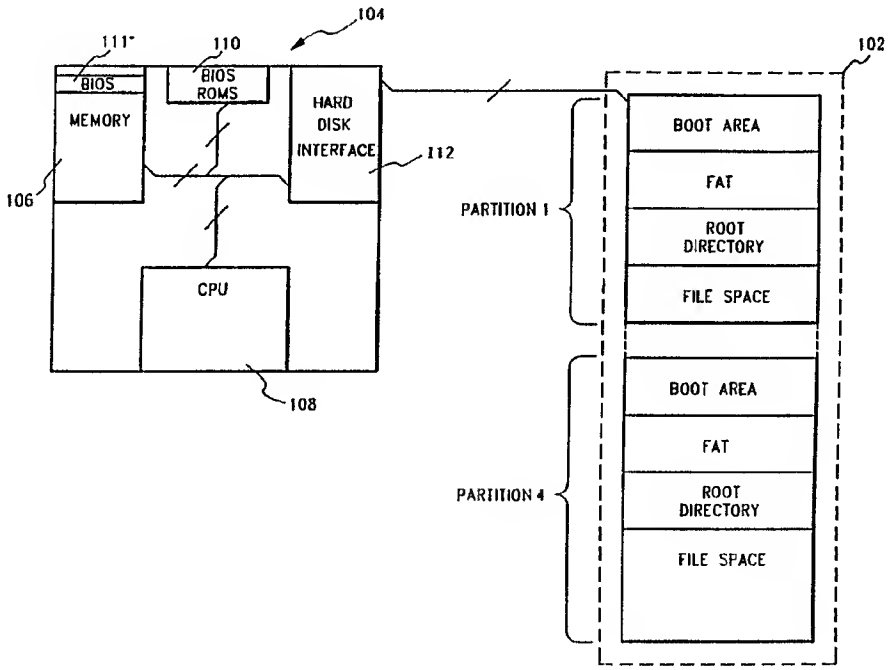

(57) Abstract

A system for multiple access hard disk (102) partitioning (202) provides a method for installing and operating multiple incompatible absolute zero sector operating systems on the same hard disk drive. This facilitates the use of a single hard disk drive in dual-compatible computers which functions selectively in an IBM® AT compatible (130, 240, 254) mode and a non-IBM® AT compatible (170, 270, 260) mode.

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+ DESIGNATIONS OF "SU"

Any designation of "SU" has effect in the Russian Federation. It is not yet known whether any such designation has effect in other States of the former Soviet Union.

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SYSTEM FOR MULTIPLE ACCESS HARD DISK PARTITIONING

Background of the Invention

Field of the Invention

The present invention relates to improvements in dual compatibility computers and involves a method for allowing operation of multiple incompatible operating systems upon different disk partitions in the same hard disk drive.

Description of the Related Art

The IBM AT compatible computer, which uses an Intel 80x86 microprocessor is one of the most common standards for desk top computers in the United States. The Intel 80x86 microprocessors are also used in computers in Japan. For example, the NEC 9801 computer utilizes such microprocessors. Many compatibilities exist between the IBM AT compatible computer standard and the NEC 9801 computer. These compatibilities make it possible to develop a double-compatible computer. However, numerous incompatibilities exist, particularly involving Input/Output (I/O) device addresses, I/O busses, peripheral devices, the Basic Input Output System (BIOS) used to manipulate hardware, and the operating systems. Some hardware incompatibilities can be solved by using hardware which is mode selectable. However, in many cases, this requires redundant hardware, each set operating in one mode or the other. This is often impractical and undesirable.

Both the IBM AT and the NEC 9801 systems allow for divisions (partitions) of the hard disk over and above the normal divisions used by the operating system. A partition table holds information regarding the disk partitions. However, no provision was made in either the IBM AT or the NEC 9801 systems for booting up under a different hardware or non-compatible software configuration. The IBM AT compatible operating system originally had partition table definitions for DOS-12, DOS-16 and Extended DOS partitions and has been extended to allow other operating systems such as XENIX,

Novell, CP/M, PCIX and others. However, these operating systems were programmed to be compatible only with the IBM AT operating system hard disk partition tables.

The NEC 9801 operating system was not programmed to be compatible with the IBM AT system, and the partition table and the Initial Program Load (IPL) boot loader of the NEC 9801 is incompatible with the partition table and IPL boot loader of the IBM AT. Moreover, each operating system assumes that its IPL and partition tables are located at absolute sector zero on the hard disk. Therefore, the IBM AT system does not provide a definition to identify that the NEC 9801 system is installed somewhere on the hard disk. If only one hard disk is used in the dual-compatible computer, then installing both operating systems will not be possible because if both systems are installed on the same hard disk then the IBM AT compatible operating system may write to the disk space occupied by the NEC partition because nothing indicates to the IBM AT system that the NEC operating system is present on the hard disk.

Likewise, the NEC operating system assumes that it has use of absolute sector zero on the hard disk and may write to disk space not allocated for its use.

Installing each operating system on a different hard disk drive provides a solution, but this requires redundant hardware. As explained, this is uneconomical and undesirable.

Tomcat Company, a Japanese corporation, attempted to solve this problem by making an assumption that the NEC 9801 compatible operating system is installed as the last partition on the hard disk and that no other disk partitions will follow the NEC 9801 system partition. This assumption solves the problem of the IBM AT system accessing NEC 9801 hard disk space. Once this assumption is made, then the NEC 9801 basic I/O system (BIOS) can reference all disk access calls to the last partition and the AT system can limit disk usage to the disk space preceding the NEC 9801 partition. However, if the user installs a partition after the NEC 9801 partition, then the 9801 operating system will not compensate for this and may access the disk outside the NEC 9801 partition. Moreover, if

the user moves the NEC 9801 partition into space allocated to the AT compatible partitions, then the AT system will not compensate for the moved NEC 9801 partition and may use disk space in the NEC 9801 partition. This results in a hard disk misfunction and possible lost data.

Accordingly, a reasonable solution to the problem would utilize a method to operate both systems without making the assumption that the user will not change the partitioning of the hard disk.

Implementing a solution should allow installation and booting of two absolute zero sector IPL code segment and accompanying partition tables on the same disk. A solution to this problem would dramatically improve the feasibility of the IBM AT/NEC 9801 dual-compatible computers.

Summary of the Invention

The present invention provides a system which allows use of two or more absolute zero sector boot loaders on the same hard disk drive by enhancing one of the partition tables and modifying the BIOS of one of the systems. The present invention allows the dual compatible computer to operate both operating systems as if the corresponding boot loader (IPL) and partition tables were installed at absolute sector zero on the hard disk.

One aspect of the present invention involves a method for operating first and second absolute sector zero boot loaders on a disk drive in a computer having first and second operating modes. The first boot loader includes first boot load instructions and a first partition table identifying a first operating system associated with the first boot loader. The second boot loader includes second boot load instructions and a second partition table identifying a second operating system associated with the second boot loader. The method comprises the steps described below.

A first boot loader is stored at absolute sector zero of the disk drive and includes a mode identifier that indicates the operating mode of the computer. A second boot loader is stored at a selected sector of the disk drive other than

sector zero. An identifier is stored for the second boot loader in the first partition table of the first boot loader. This identifier includes a pointer to the selected sector at which the second boot loader is loaded. Upon initialization of the computer, the first boot load instructions are executed, and, when the mode identifier indicates that the computer is in the second operating mode, the second boot load instructions are executed after executing the first boot load instructions to enable the operating system associated with the second boot loader. Under this method, the second boot loader operates without modification as if loaded at absolute sector zero.

The computer includes a basic I/O system (BIOS) that controls access to the disk drive, and the method also further includes the steps of storing a mode indicator when initializing the computer to designate which of the first and second operating systems is active; and responding to a disk access request that includes an address to a sector of the disk by checking the mode indicator and adding an offset to the address equal to the absolute address of the selected sector of the disk when the mode indicator designates the second operating system.

The second partition table also includes sector numbers that identify partition boundaries for sectors allocated to the second operating system. These partition boundaries are referenced to absolute sector zero, but the sectors allocated to the second operating system are physically located on the disk at absolute sector addresses above the selected sector. The BIOS automatically adds the offset to addresses for disk accesses from the second operating system so that the second operating system can reference disk addresses to absolute sector zero and transfer data to and from the sectors allocated to the second operating system.

Brief Description of the Drawings

Figure 1 illustrates a simplified block diagram of an IBM AT compatible computer including the simplified organization

of a hard disk space usage.

Figure 2 illustrates the organization of an IBM-AT compatible partition table.

Figure 3 illustrates a more detailed view of the organization of one partition cell of Figure 2.

Figure 4 illustrates the organization of an NEC 9801 compatible partition table.

Figure 5 illustrates a more detailed view of the organization of one partition cell of Figure 4.

Figure 6 illustrates a modified IBM AT partition table of the present invention.

Figure 7 illustrates a block diagram for booting the dual-compatible computer of the present invention.

Figure 8 illustrates a block diagram for disk functions performed according to the present invention.

Detailed Description of the Preferred Embodiment

Figure 1 illustrates a block diagram of a hard disk 102 and its basic supporting platform resources 104, including a memory 106, a CPU 108, BIOS ROMs (Read Only Memory) 110, BIOS space 111 allocated in the memory 106 and a hard disk interface 112. It also shows the simplified organization of the hard disk 102.

The hard disk can be divided into consecutive partitions (physical divisions in the disk drive). These partitions may be used by various operating systems and each partition is owned by its corresponding operating system. The partitions of a disk drive are defined in a partition block located at the physical first sector of the hard disk.

An AT compatible partition block 130 located at the physical first sector of the hard disk (absolute sector zero) is shown in Figure 2. This partition block 130 consists of an initial program load (IPL) segment 132 which provides a boot loader, four partition identifier segments 133, 134, 135, 136 corresponding to four potential disk partitions P4, P3, P2, and P1 respectively, and a boot segment 138.

Each of the partition identifier segments 133, 134, 135, and 136 comprises 16 bytes of disk space making up a partition

table 140 (Figure 3) containing identification information for the corresponding disk partition.

Because the same organization applies to all four partition identifier segments 133, 134, 135, and 136 which correspond to disk partitions P4, P3, P2, and P1 respectively, the information provided in each partition table 140 is described in reference to partition identifier segment 133 which corresponds to partition P4 only.

The partition table 140 comprises a boot indicator byte 141 to identify whether the corresponding partition segment P4 is a bootable partition or a non-bootable partition. Only one partition of P4, P3, P2, and P1 may be bootable at a given time. The partition table further comprises a physical starting head number byte 142, a physical starting cylinder and physical starting sector segment 144, a system indicator byte 148 which identifies the type of operating system, a physical ending head number byte 150, a physical ending cylinder and physical ending sector segment 152, a boot sector address segment 154, and a sector number segment 156 which indicates the number of sectors in the partition P4 as is well understood in the art.

The system indicator byte 148 utilizes pre-defined identifiers (e.g. 01H identifies IBM/MS DOS with a 12 bit File Allocation Table (FAT)) to designate any IBM AT compatible operating system such as IBM/MS-DOS (12 bit FAT, 16 bit FAT, and Extended DOS), XENIX, NOVELL, CP/M, PCIX, or non-DOS as is well understood in the art. Note that NEC 9801 would normally fall into the non-DOS category, but the partition tables and IPL code are not compatible.

An exemplary NEC 9801 compatible partition block 170 is shown in Figure 4. The NEC 9801 compatible partition block 170 is similar, but not identical to the IBM AT compatible partition block 130. The NEC 9801 partition block 170 is conventionally located at the first physical sector in the hard disk. This partition block 170 comprises an NIPL (NEC initial program load) boot loader 172, sixteen partition identifier segments 173-188 corresponding to sixteen potential

partitions NP1-NP16 on the hard disk 102, and a boot segment 190. Each of the partition identifier segments 173-188 comprises 32 bytes of disk space forming a partition table 200 (Fig. 5) for each corresponding partition NP1-NP16.

The contents of an exemplary partition table 200 corresponding to NP1 are shown in Figure 5. This partition table 200 comprises a partition identifier segment 202 which indicates whether the partition NP1 is bootable, a system identifier segment 204 which indicates whether partition NP1 is active (accessible by the operating system), an open segment 206, an IPL sector segment 208 which indicates the boot sector address, a physical volume starting address segment 210 which indicates the physical starting address for the partition NP1, a physical volume ending address segment 212 which indicates the ending address for the partition NP1, and a volume segment 214 as is well understood in the art. One advantage of the present invention is that no modifications to the contents of the NEC 9801 partition block 170 and the corresponding partition table 200 are necessary. Therefore, no further explanation of the NEC 9801 partition block 170 is necessary.

The IBM AT partition block 130 and the NEC 9801 partition block 170 can not co-exist at the physical first sector (absolute sector zero) on the same hard disk 102. However, the present invention provides a method whereby the AT compatible and NEC 9801 compatible bootable operating systems can be located on the same hard disk drive without modification to the operating system. To allow for both operating systems on the same disk, the AT partition block is enhanced as described below.

Figure 6 illustrates an enhanced AT compatible partition block 240 of the present invention which is located at the physical first sector on the hard disk 102. The AT partition block is enhanced to include a mode identifier 242 in the last two bytes in the IPL segment 132. This mode identifier 242 indicates the mode of computer operation--NEC 9801 or IBM AT compatible.

The corresponding partition tables 140 are unaltered except that a new system identifier for the NEC 9801 operating system is provided. The previously undefined system identifier for the NEC 9801 compatible system can be stored in the system indicator byte 148 of the partition table 140.

According to the present invention, if, for instance, partition P2 is chosen for NEC 9801 partition installation as shown in Figure 6, this newly defined identifier indicates to other AT partition table compatible operating systems occupying the other partitions P1, P3, and P4 that partition P2 and its corresponding disk space are used by the NEC 9801 operating system. This prevents the other operating systems from writing to disk space used by the NEC 9801 system.

The NEC 9801 partition block 170 is then located on the disk at a location other than absolute sector zero. However, the NEC 9801 operating system uses logical sector addresses to access the hard disk assuming that the NEC 9801 partition block 170 is located at absolute sector zero on the hard disk. Under the present invention, the unmodified NEC 9801 operating system continues to access the disk as if the NEC 9801 partition block 170 were located starting at absolute sector zero.

A NEC 9801 compatible BIOS (not shown) generally controls disk function requests from the NEC 9801 compatible operating system. To allow the NEC 9801 operating system to properly access its corresponding partitions when the partition block 170 is not located at absolute sector zero requires modification to the NEC 9801 compatible BIOS controller disk access routines as describe hereinafter.

Computer Boot Sequence

Upon start-up of the dual-compatible computer, the system follows a program load sequence depicted in the flow chart 250 depicted in Figure 7. A user of the dual-compatible computer can initiate start-up operations according to two methods: powering the system on (cold-boot) and performing a reset (warm-boot) from a keyboard (not shown). In either case, the AT compatible BIOS must check the boot mode of the computer as

represented in decision tree 252.

Upon cold-boot, the computer always starts boot (IPL) at absolute sector zero on the hard disk. The AT compatible BIOS scans the IPL 132 of the partition block 240 and locates the mode indicator 242 to determine in which mode the computer should boot. If the mode indicator 242 identifies AT compatible as the computer mode, the computer proceeds with an AT compatible IPL boot load sequence as represented by activity block 254, as is well understood in the art. If the mode indicator 242 identifies the NEC 9801 mode as active, then the IPL scans 256 the partition table to determine the boundaries of the active NEC 9801 compatible partition as represented in activity block 256. These boundaries provide an offset for all subsequent logical address hard disk function calls. This offset is then stored in the memory 106 in the BIOS space 111. Then, the NEC BIOS (not shown) is reset (moved into BIOS space 111 in memory 106) as represented by activity block 258, and the computer continues with an IPL boot load sequence for the NEC 9801 mode as represented by activity block 260.

If start-up is initiated by a warm-boot, then a bit is set in a CMOS (complementary metal oxide semiconductor, not shown) indicating the mode of computer operation. The AT compatible BIOS checks the boot mode (acativity block 252) by checking the bit in the CMOS to determine the operating mode of the computer and ignores the mode indicator 242 in the enhanced partition block 240. The start-up operations then proceed as previously described for a cold-boot as shown in the flow-chart 250 in Figure 7.

NEC 9801 Disk Function Calls

Because the AT compatible partition block 240 is located at absolute sector zero of the hard disk, no adjustments are made for disk functions in the AT compatible mode. Therefore, if the computer is not operating in the NEC 9801 mode, it will perform conventional AT compatible disk functions, as is well understood in the art.

The NEC 9801 compatible system also assumes that the NEC

9801 compatible partition block 170 is located at absolute sector zero on the hard disk. However, the NEC 9801 compatible partition block 170 is installed at a sector other than absolute sector zero. Thus, when the computer operates in the NEC 9801 compatible mode, disk function calls must be adjusted for the appropriate sector on the hard disk where the NEC 9801 partition block 170 is located.

When the NEC 9801 operating system requests a disk function, the BIOS in memory 111 (which is a copy of the NEC 9801 compatible BIOS) receives a disk access call, and the BIOS 111 performs the procedure as illustrated in the flow chart 270 in Figure 8. The BIOS 111 reads the offset, represented by activity block 272, obtained upon start-up from the enhanced AT compatible partition block 240. The BIOS 111 then adds the offset to the logical address requested by the operating system disk function call and obtains an adjusted disk address, represented by activity block 274. The disk function is then performed using the adjusted address, represented by activity block 276. Because the NEC 9801 compatible operating system uses logical sector addressing, this offset is transparent to the operating system.

If a device driver (not shown) or a user needs to access disk space outside of the NEC 9801 partition then absolute disk address calls can be used which bypass the NEC 9801 compatible BIOS.

By performing the address offset at the NEC 9801 compatible BIOS level, an NEC 9801 compatible operating system requires no modification and may issue all disk function requests as it would in a NEC 9801 compatible computer.

Other embodiments of the present invention will be obvious to those skilled in the art and will not detract from the subject matter regarded as invention.

CLAIMS:

1. A method for operating first and second absolute sector zero boot loaders on a disk drive in a computer having first and second operating modes, said first boot loader including first boot load instructions and a first partition table identifying a first operating system associated with said first boot loader, said second boot loader including second boot load instructions and a second partition table identifying a second operating system associated with said second boot loader, comprising the steps of:

storing said first boot loader at absolute sector zero of said disk drive, said first boot loader including a mode identifier that indicates the operating mode of said computer;

storing said second boot loader at a selected sector of said disk drive other than sector zero;

storing an identifier for said second boot loader in said first partition table of said first boot loader, said identifier including a pointer to said selected sector at which said second boot loader is loaded; and

upon initializing said computer, executing said first boot load instructions, and, when said mode identifier indicates that said computer is in said second operating mode, executing said second boot load instructions after executing said first boot load instructions to enable said operating system associated with said second boot loader, said second boot loader operating as if loaded at absolute sector zero without modification of said second boot loader.

2. The method as defined in Claim , wherein said computer includes a basic I/O system (BIOS) that controls access to said disk drive, said method further including the steps of:

storing a mode indicator when initializing said computer to designate which of said first and second operating systems is active;

responding to a disk access request that includes an address to a sector of said disk by performing the steps of:

reading said mode indicator; and

when said mode indicator designates said second operating system, adding an offset to said address equal to the absolute address of said selected sector of said disk.

3. The method as defined in Claim , wherein said second partition table includes sector numbers that identify partition boundaries for sectors allocated to said second operating system, said partition boundaries referenced to absolute sector zero, said sectors allocated to said second operating system physically located on said disk at absolute sector addresses above said selected sector, said BIOS automatically adding said offset to addresses for disk accesses from said operating system so that said second operating system can reference disk addresses to absolute sector zero and transfer data to and from said sectors allocated to said second operating system.

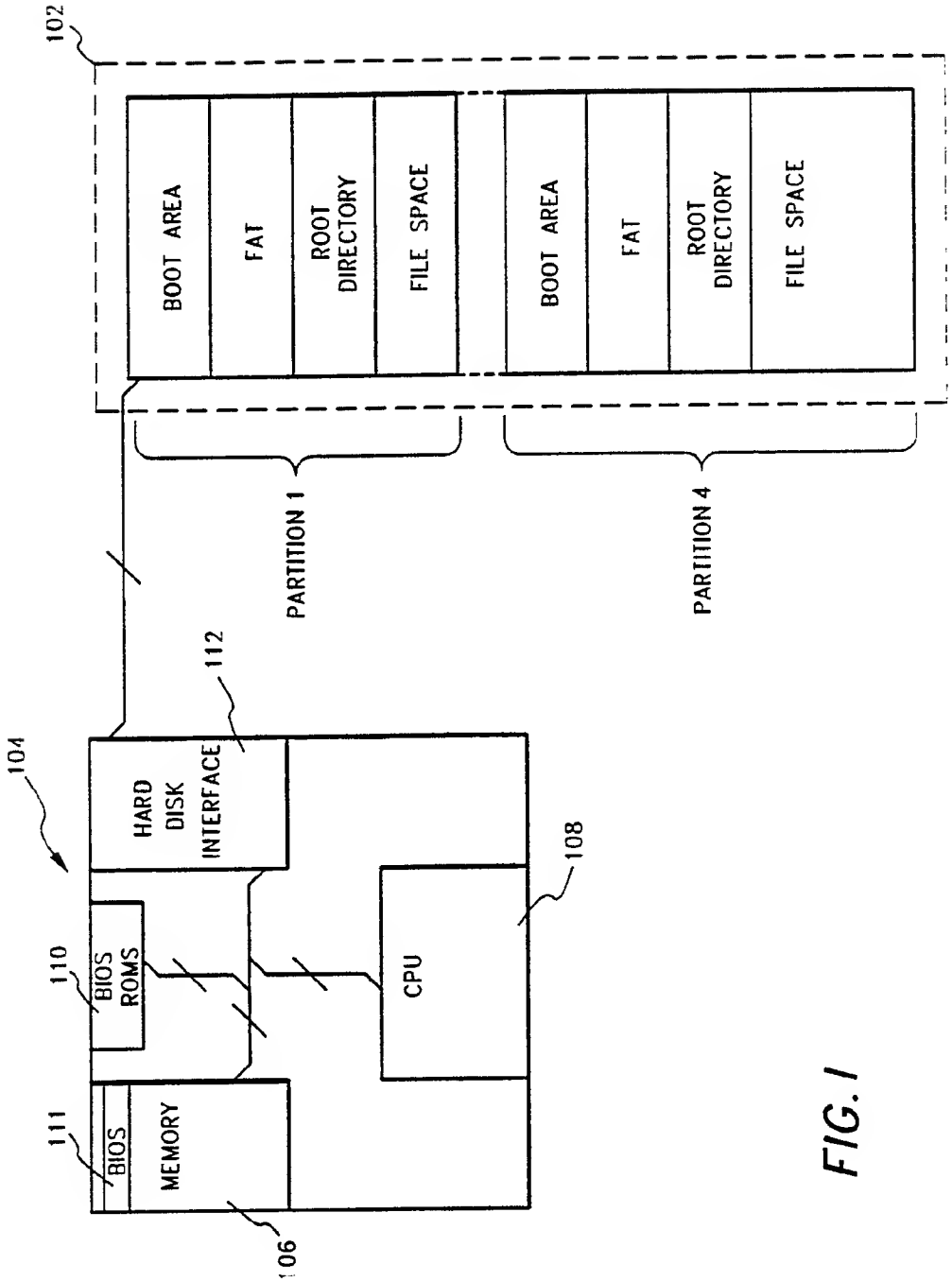
102
BOOT AREA
FAT
ROOT DIRECTORY
FILE SPACE
BOOT AREA
FAT
ROOT DIRECTORY
FILE SPACE
PARTITION 1
PARTITION 4
104
112
HARD DISK INTERFACE
108
CPU
110
BIOS ROMS
111
BIOS
MEMORY
106

FIG. 1

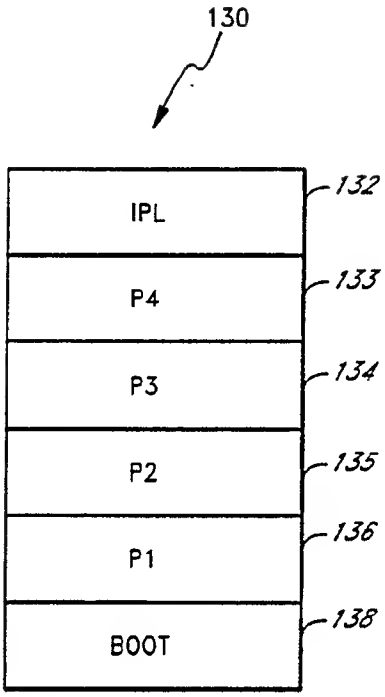
130
IPL
132
P4
133
P3
134
P2
135
P1
136
BOOT
138

FIG. 2

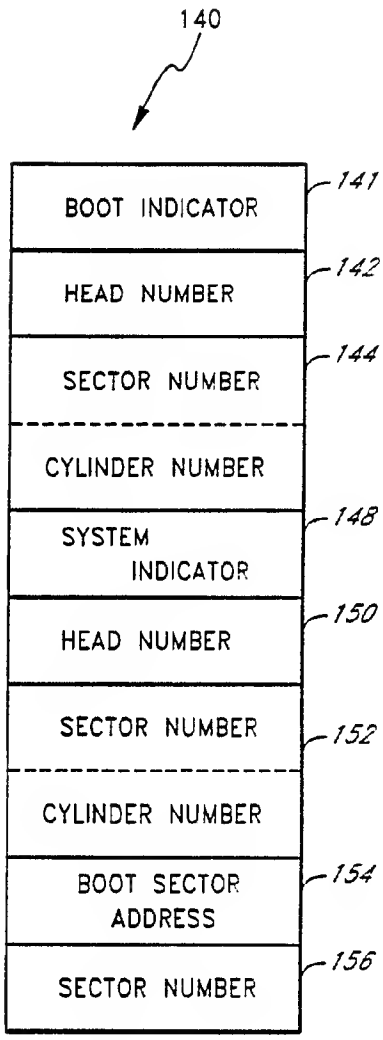
140
BOOT INDICATOR
141
HEAD NUMBER
142
SECTOR NUMBER
144
CYLINDER NUMBER
SYSTEM INDICATOR
148
HEAD NUMBER
150
SECTOR NUMBER
152
CYLINDER NUMBER
BOOT SECTOR ADDRESS
154
SECTOR NUMBER
156

FIG. 3

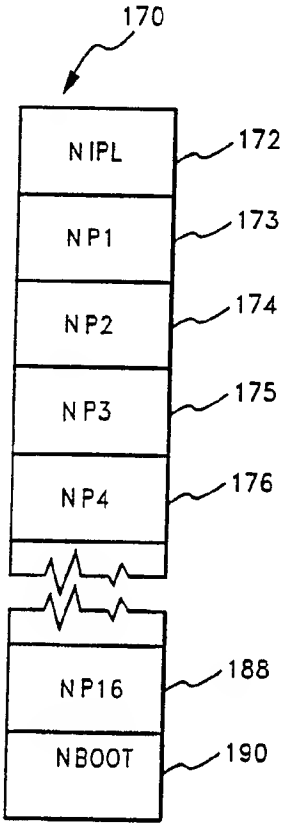

FIG.4

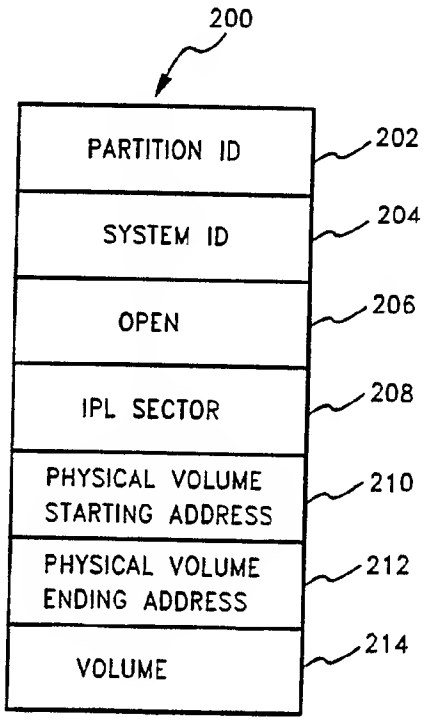

FIG.5

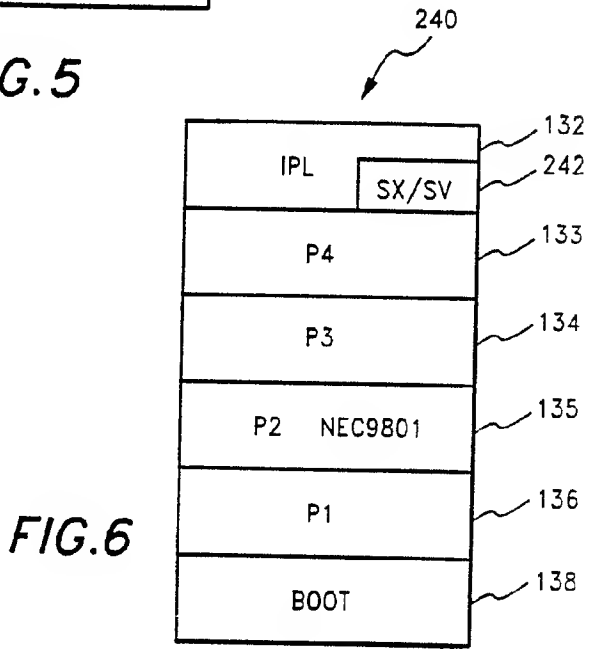

FIG.6

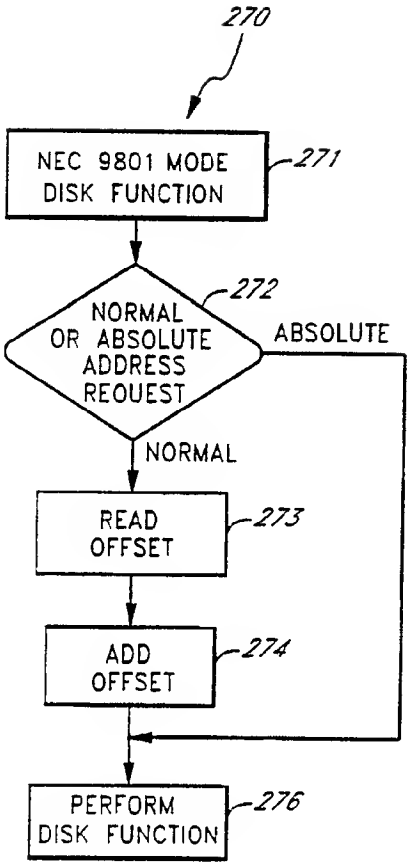
270
NEC 9801 MODE DISK FUNCTION
271
NORMAL OR ABSOLUTE ADDRESS REQUEST
272
ABSOLUTE
NORMAL
READ OFFSET
273
ADD OFFSET
274
PERFORM DISK FUNCTION
276

FIG. 8

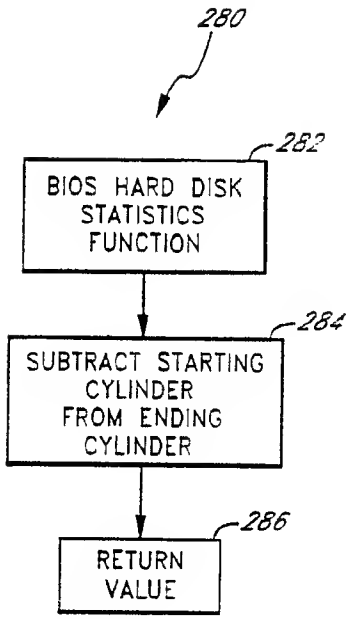
280
BIOS HARD DISK STATISTICS FUNCTION
282
SUBTRACT STARTING CYLINDER FROM ENDING CYLINDER
284
RETURN VALUE
286

FIG. 9

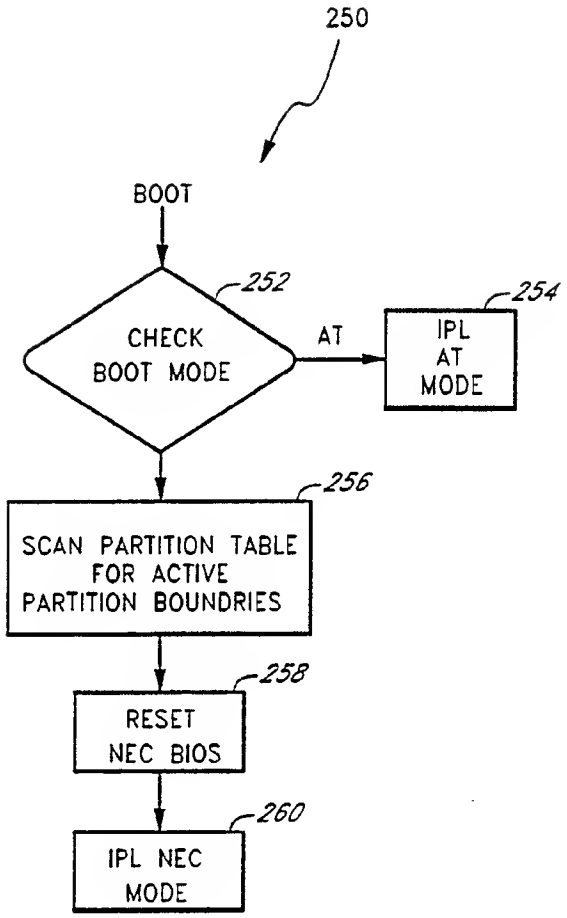
250
BOOT
252
CHECK BOOT MODE
AT
254
IPL AT MODE
256
SCAN PARTITION TABLE FOR ACTIVE PARTITION BOUNDRIES
258
RESET NEC BIOS
260
IPL NEC MODE

FIG. 7

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US91/07736

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC(5): G06F 9/06
U.S. CL. 395/700

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
U.S. CL.	395/700; 364/Dig. 1, Dig. 2

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A,P	US,A, 4,984,149 (IWASHITA) 08 JANUARY 1991 See the entire document	1-3
A,P	US,A, 4,982,324 (McCONAUGHY) 01 JANUARY 1991 See the entire document	1-3
A	US,A, 4,928,237 (BEALKOWSKI) 22 MAY 1988 See the entire document	1-3
A	US,A, 4,779,187 (LETWIN) 18 OCTOBER 1988 See the entire document	1-3

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
29 JANUARY 1992	25 FEB 1992
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